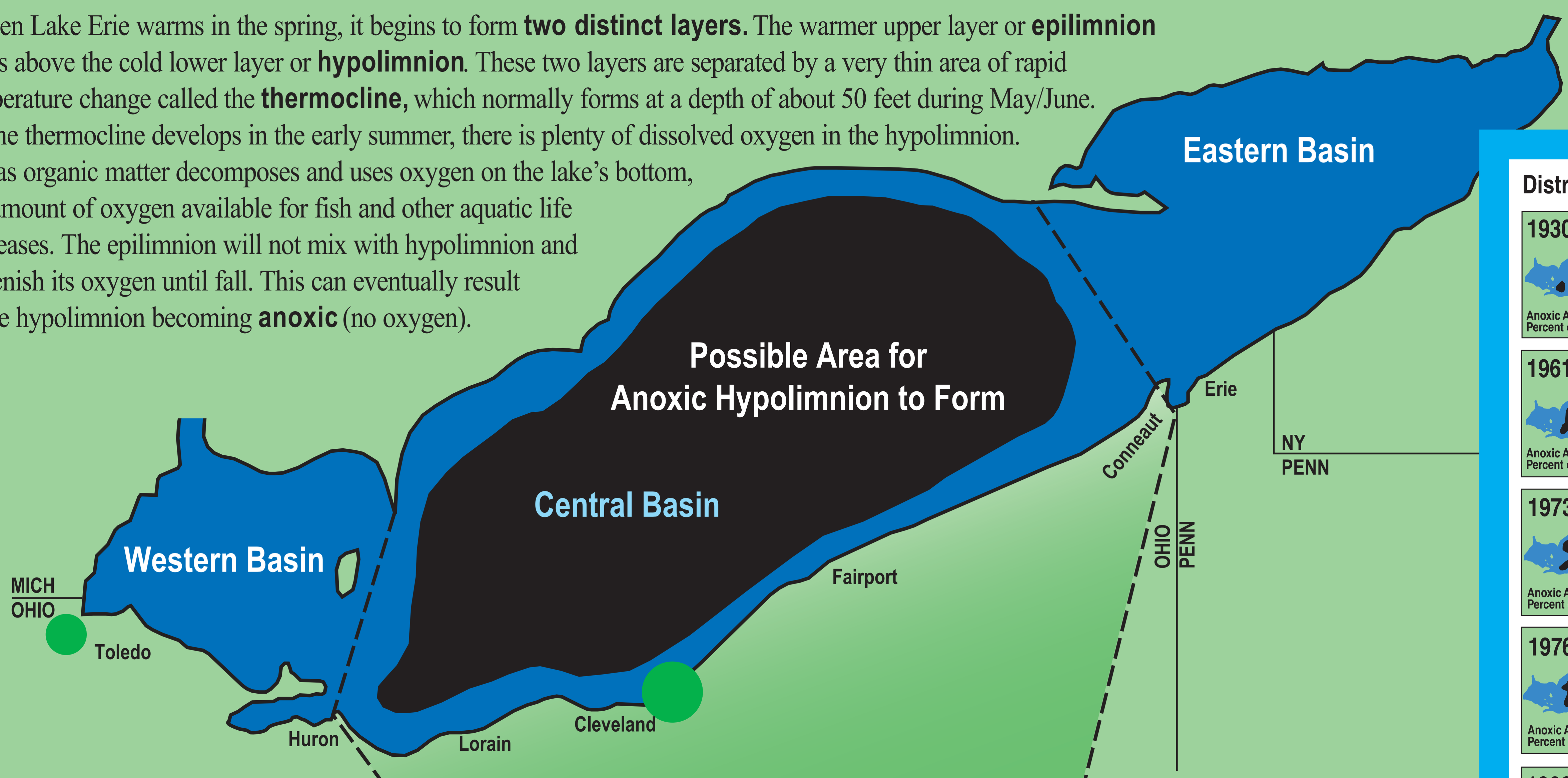
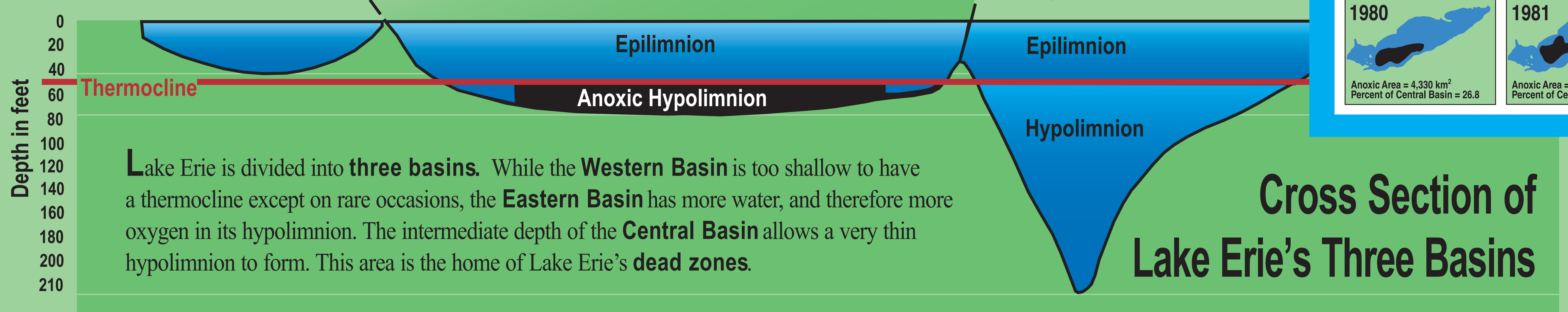
Understanding Lake Erie's "Dead Zones"

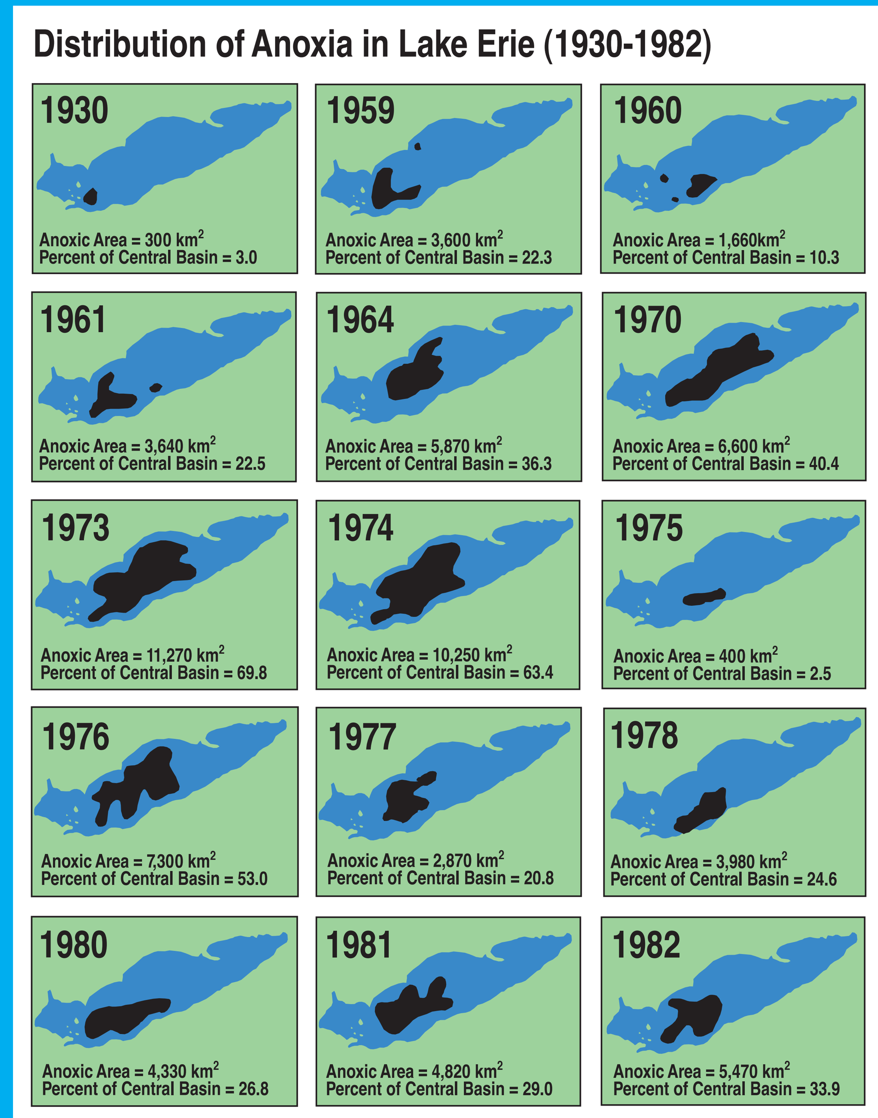
When Lake Erie warms in the spring, it begins to form **two distinct layers.** The warmer upper layer or **epilimnion** floats above the cold lower layer or **hypolimnion**. These two layers are separated by a very thin area of rapid temperature change called the **thermocline,** which normally forms at a depth of about 50 feet during May/June. As the thermocline develops in the early summer, there is plenty of dissolved oxygen in the hypolimnion. But as organic matter decomposes and uses oxygen on the lake's bottom, the amount of oxygen available for fish and other aquatic life decreases. The epilimnion will not mix with hypolimnion and replenish its oxygen until fall. This can eventually result in the hypolimnion becoming **anoxic** (no oxygen).





Lake Erie is divided into **three basins.** While the **Western Basin** is too shallow to have a thermocline except on rare occasions, the **Eastern Basin** has more water, and therefore more oxygen in its hypolimnion. The intermediate depth of the **Central Basin** allows a very thin hypolimnion to form. This area is the home of Lake Erie's **dead zones**.

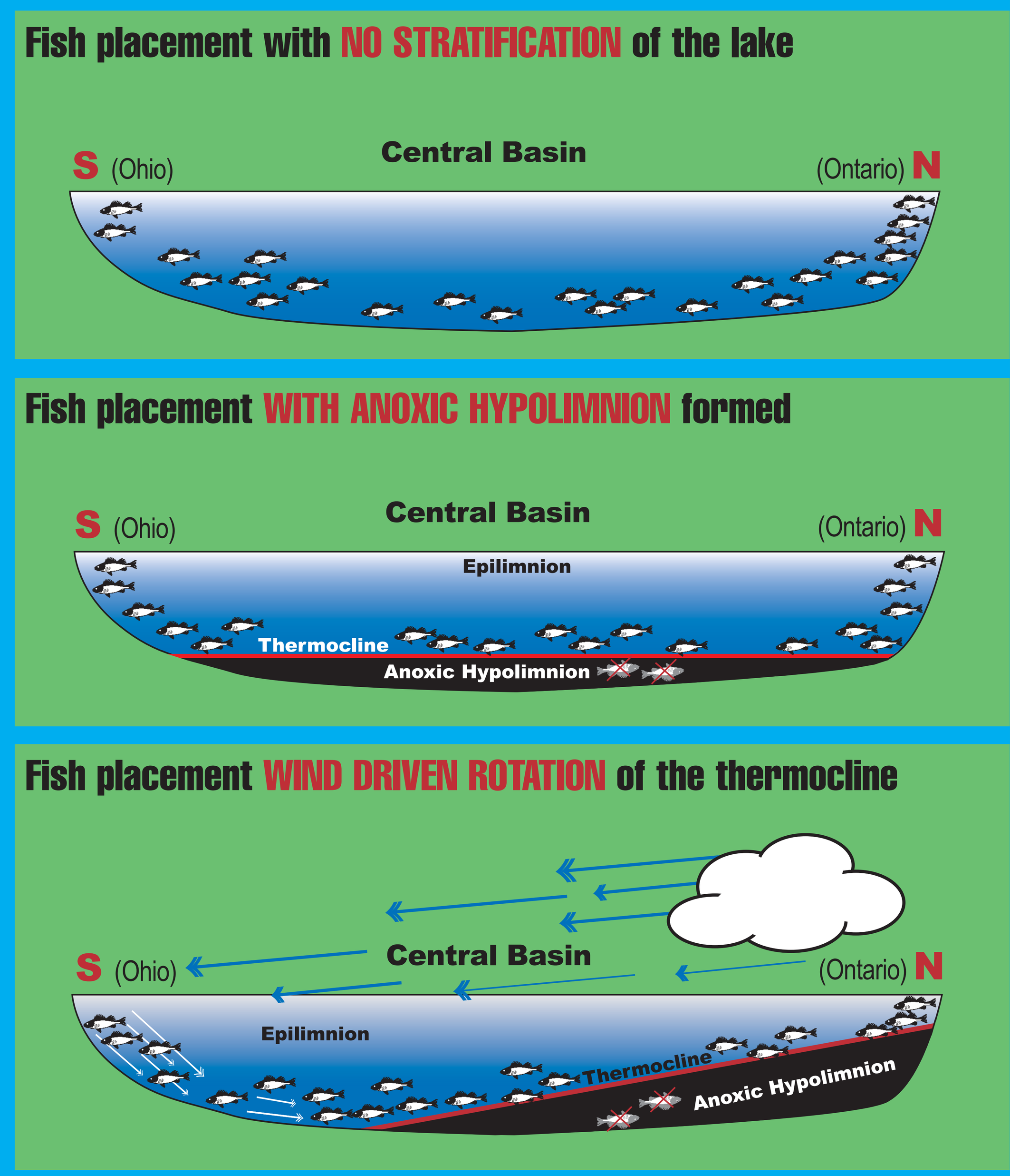
Cross Section of Lake Erie's Three Basins



Are These Zones New to Lake Erie?

Dead zones or **anoxic areas** have been reoccurring in Lake Erie since 1930 (earliest recorded research). Although **phosphorus** occurs naturally in Lake Erie, phosphorus going into the lake increased dramatically when phosphorus-based detergents replaced soap in the 1940s. As agriculture relied on **fertilizers** for farm production, agricultural **run-off** into the lake contained more phosphorus. By 1973, almost 70 percent of the water below the thermocline in the Central Basin was anoxic. By improving **sewage** treatment plant technology, reducing the use of agricultural fertilizers, and decreasing the amount of phosphorus in **detergents**, phosphorus loads decreased over 50 percent by 1982. The extent of anoxia has worsened since the late 1990s.

Chart represents data collected between 1930 - 1982. Data has not been collected since 1982 due to funding reductions.



What Causes the Zones?

Although anoxic areas have existed since the 1930s, the Lake has survived. However, anoxic areas are not good for any water body. Understanding what causes dead zones will help us find ways to eliminate them. Some possibilities are:

Excessive Runoff of Nutrients (Phosphorus)

As anoxic areas became more common in the late 1960s, researchers found that phosphorus was the culprit (limiting nutrient). Research indicated that by reducing the amount of phosphorus entering the lake, the amount of algae could consequently be reduced. When algae sink to the lake's bottom and are decomposed by bacteria, the bacteria use up too much oxygen and cause the hypolimnion to become anoxic. The amount of phosphorus entering the lake from municipal, industrial, and farm run-off decreased by the early 1980s and dead zones decreased significantly in size. Even with phosphorus restrictions, phosphorus levels have begun to increase again.

Zebra and Quagga Mussels

Early research results indicate that as mussels process organic matter, they excrete phosphorus into the water where it is repeatedly used instead of going into the sediments. Therefore, more zebra mussels may mean more phosphorus and ultimately less oxygen. In addition, massive quantities of zebra and quagga mussels die annually, contributing to oxygen loss as the dead mussels are decomposed by bacteria.

Organic Matter

Organic matter which sinks and decomposes will use oxygen. More decomposition leads to increased oxygen consumption and a larger dead zone or a dead zone that lasts longer.

Low Water Levels

As Lake Erie's water level drops, the volume of the hypolimnion is reduced, and the amount of available oxygen decreases. If water levels continue to decline, the anoxic area may cover less of the lake's bottom, but arrive earlier, and last longer each year.

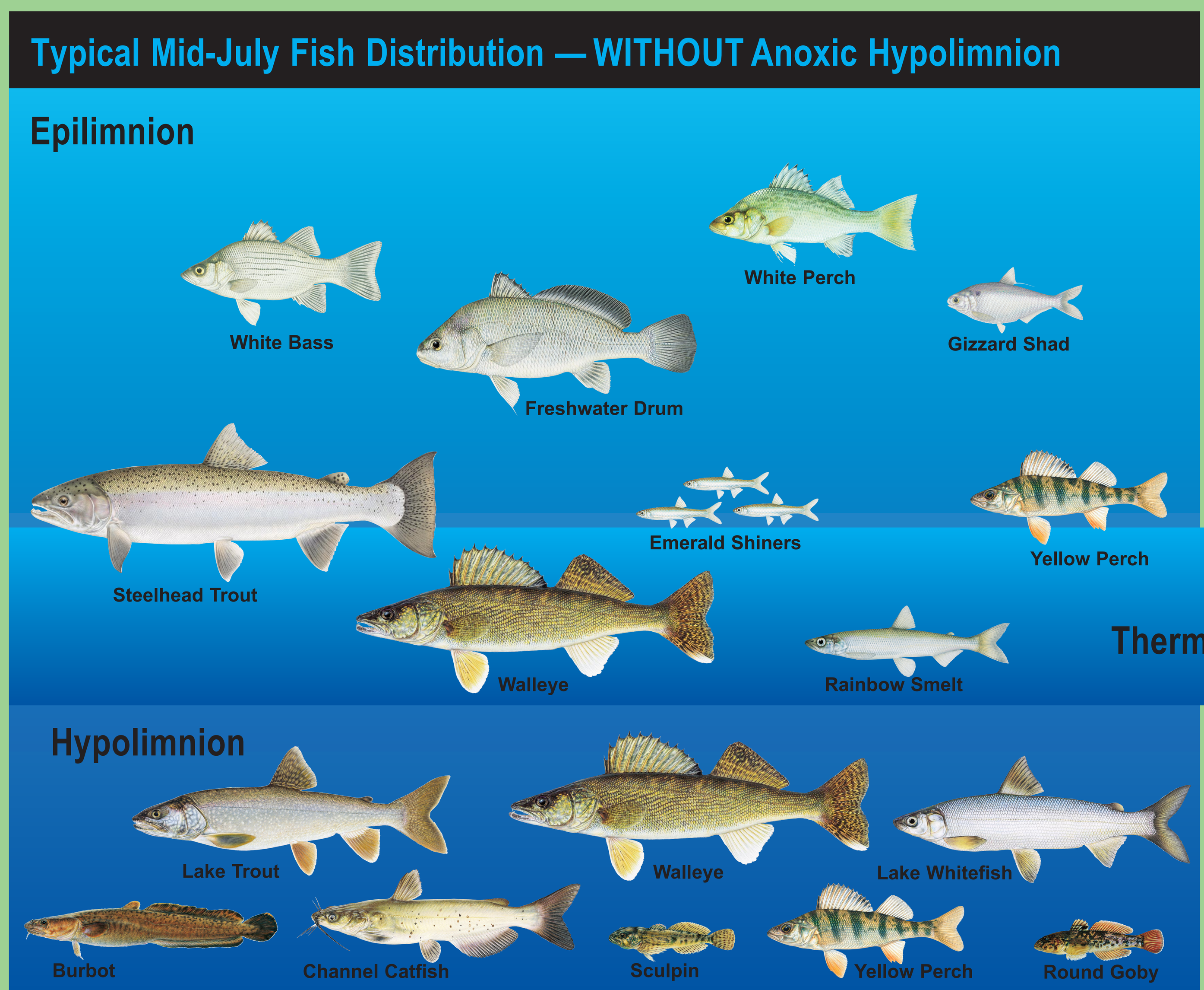
Inaccurate Reporting of Phosphorus Levels

As the lake improved in the 1980s, various governmental groups reduced monitoring efforts. Therefore, it is possible that current estimates of the amount of phosphorous entering the lake are inaccurate.

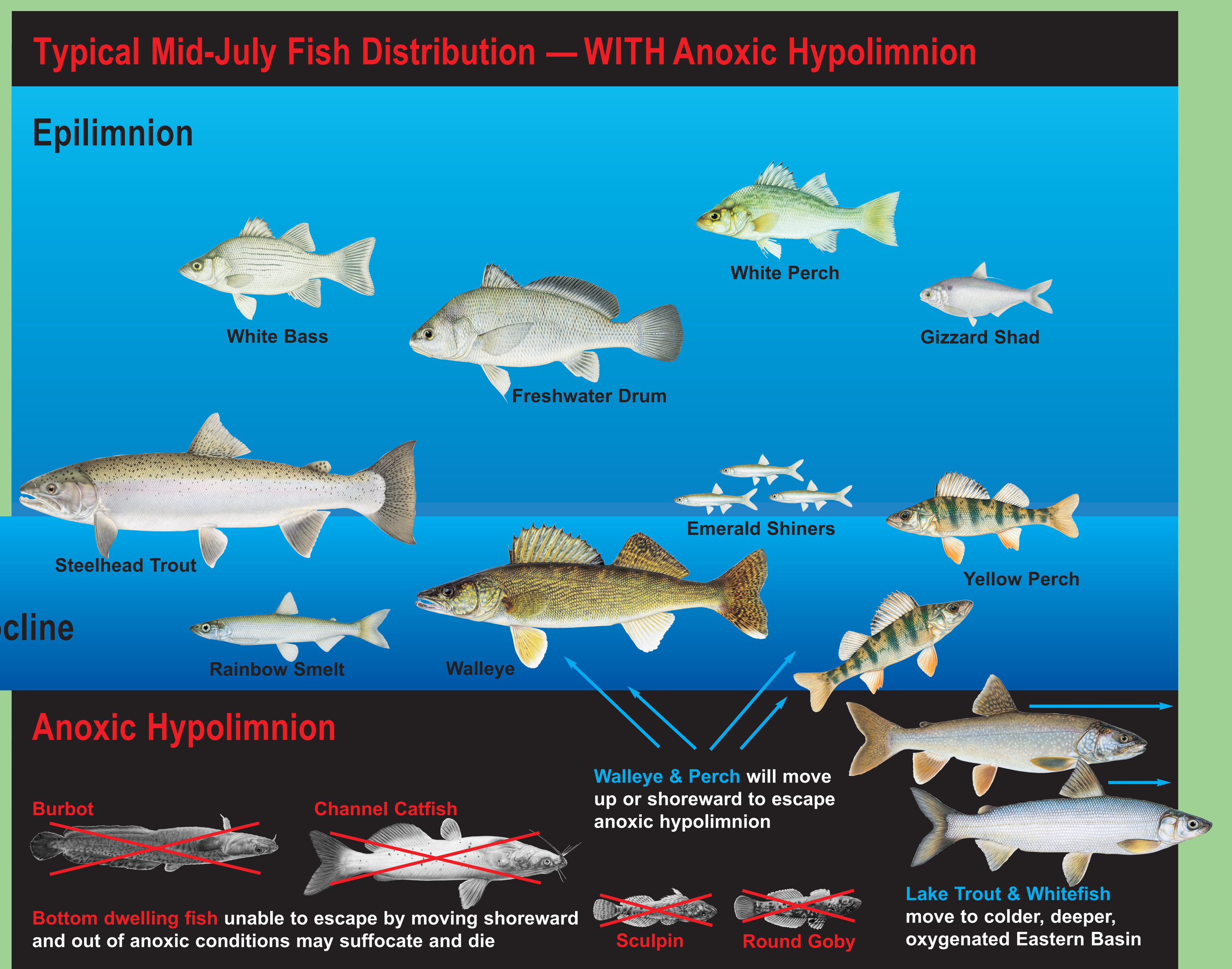
What Happens to the Fish?

When no temperature layers (**stratification**) are present, oxygen levels will be sufficient for fish from surface to bottom. Fish location will depend upon the location of **food** sources and preferred **habitats** for a given fish species. If anoxic conditions (no oxygen) develop in the hypolimnion, fish will seek higher **oxygen** levels by rising up and into or above the thermocline or by moving shoreward into shallower water depths. Fish unable to **escape** the anoxic zone will suffocate. Fish kills may occur if there is **anoxia** and periods of high northern or southern **winds**. For example, a strong north wind piles the warm surface layer up on the south shore. This forces the thermocline deeper and causes the cold bottom layer to flow to the north shore, pushing anoxic water into shallow depths and **trapping** fish. This results in a fish kill on the north shore. Strong spring and fall winds, however, generally occur before the thermocline develops or after its disappearance when there is plenty of oxygen throughout the water column.

Typical Mid-July Fish Distribution — WITHOUT Anoxic Hypolimnion



Typical Mid-July Fish Distribution — WITH Anoxic Hypolimnion



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